

# NOAA G-4 AVAPS II Dropsonde Inter-comparison NASA Global Hawk Mini Dropsonde

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And all NOAA and NASA staff in the  
planning and execution of these flights.



# NCAR Dropsonde Technology

Precision In-situ high vertical resolution measurements



	AVAPS II	Mini
Sensors	PTH & Winds	PTH & Winds
Mass	320 g	167 g
Size	16" x 2.75"	12" x 1.75"
Fall Speed	~11 m/s at surface	~11 m/s at surface



AVAPS II Dropsonde  
Operational NOAA Standard

AVAPS II Dropsonde



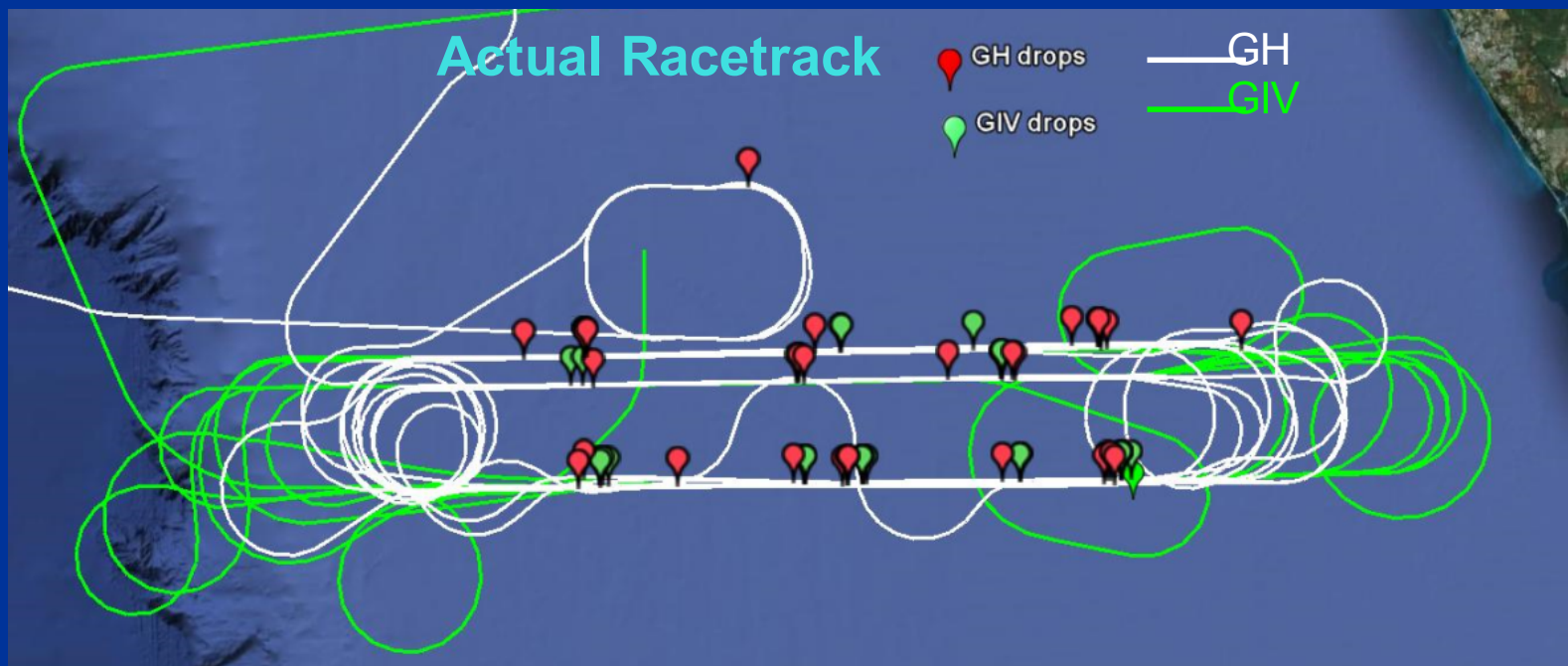
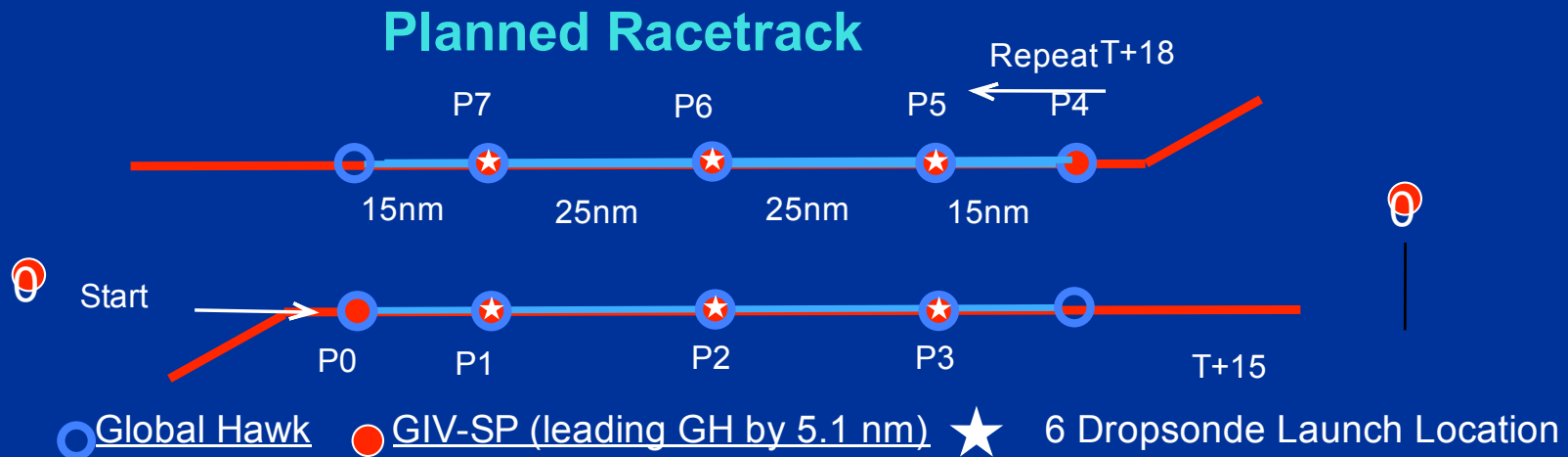
Mini Dropsonde



Mini Dropsonde  
Global Hawk

# Flight Pattern and drop locations

## Total 27 pairs on 9/14/2012 11-15 UTC (7-11am EST)

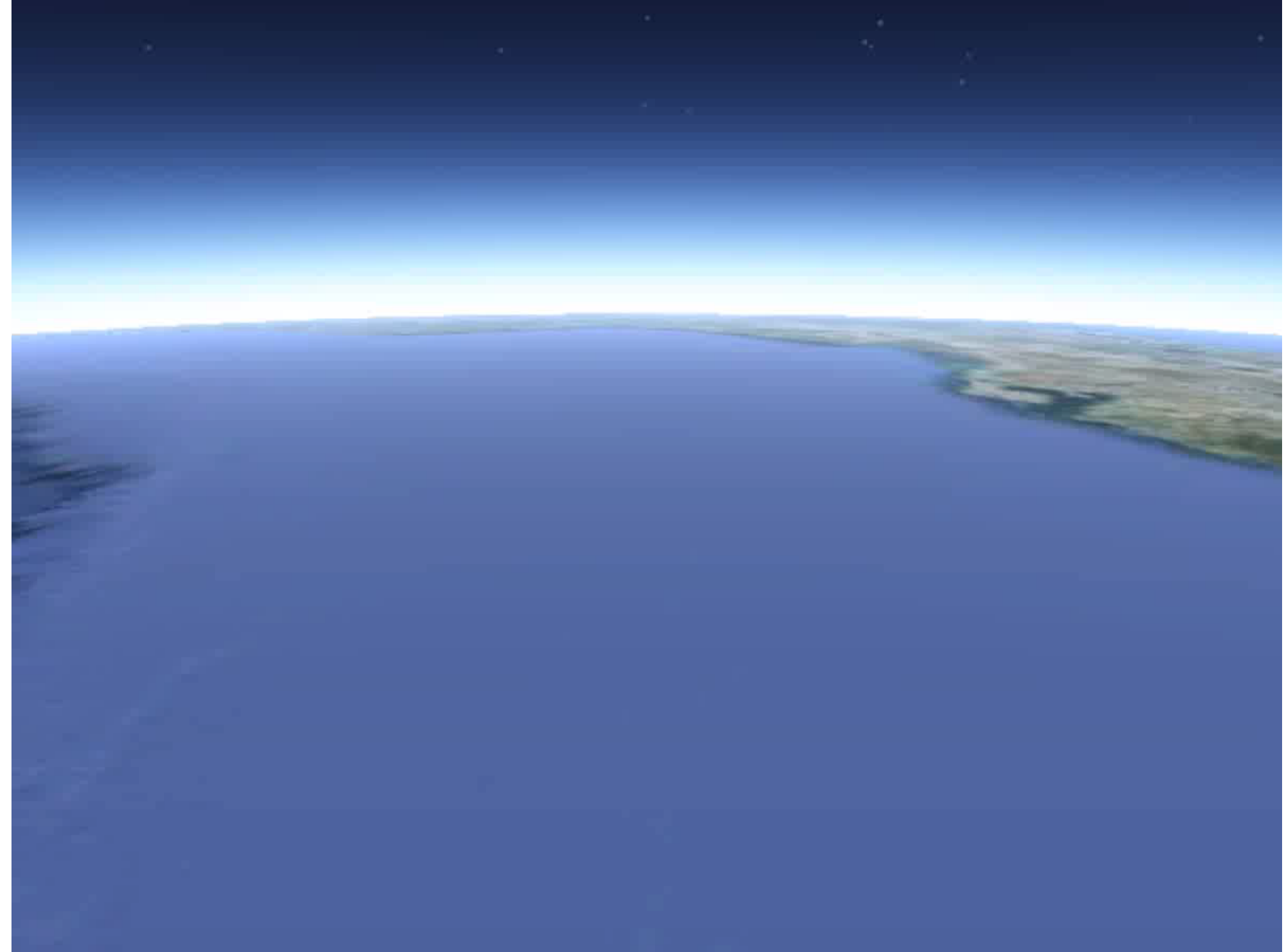




# G-IV and GH Flight Tracks

White  
NASA Global Hawk

Green  
NOAA G-IV



# Dropsonde Thermodynamic Sensors

Same High Quality Precision sensors in both sondes

## Pressure-Temperature-Humidity Sensors

- Vaisala RSS904 module  
(Similar module as standard Vaisala RS-92 Radiosonde)
- Sensor have wide dynamic range
- Very Fast Time Response P T H
- Minimal radiation errors

Vaisala RSS904 PTH sensor module

Pressure

Temperature



Dual Humidity

- Pressure
  - Range: 1080 -3 mb
  - Resolution: 0.01 mb
  - Accuracy:
    - Repeatability: 0.4 mb
- Temperature
  - Range: -90° to +60° C
  - Resolution: 0.01° C
  - Accuracy:
    - Repeatability: 0.2 ° C
- Humidity (dual sensors)
  - Range: 0% to 100%
  - Resolution: 0.1 %
  - Accuracy:
    - Repeatability: 2%

Info from Vaisala data sheet

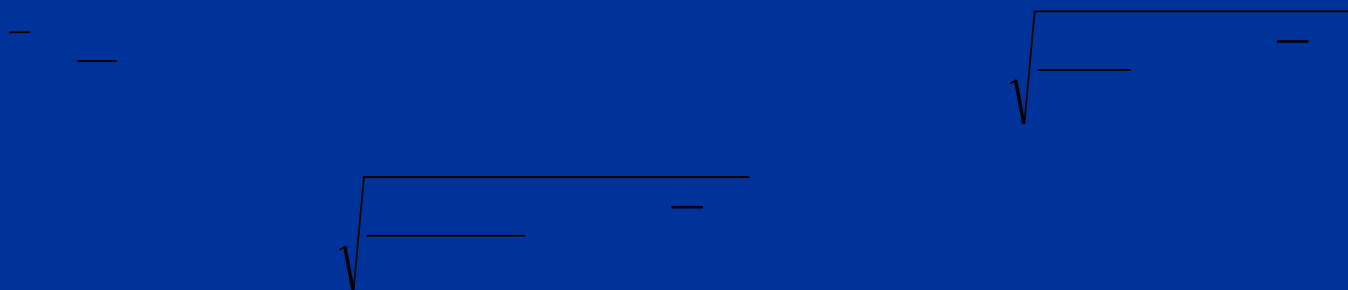
# Wind Measurements

- Winds derived by tracking sonde motion
  - GPS Receiver
  - Very Stable descent
  - Both sondes use same GPS Receiver and same parachute design
- Winds (GPS rcvr vel. specs)
  - Range: 0 to 100 m/s
  - Resolution: 0.01 m/s
  - Accuracy : 0.1 m/s
- Stable Cone Parachute design
  - Size scaled for mass of both sondes for same fall velocity



# Repeatability / Reproducibility is ...

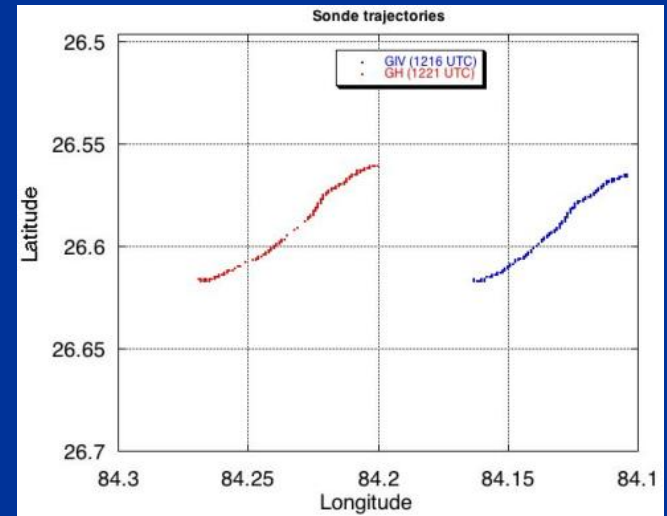
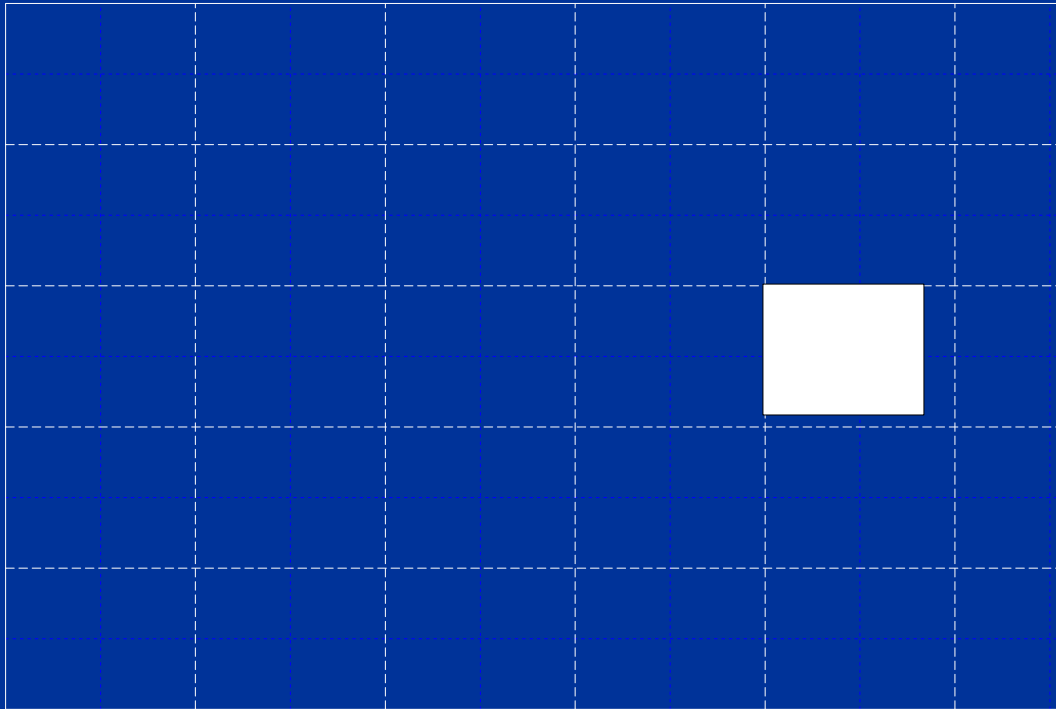
- **Repeatability** is the closeness of the agreement between the result of successive measurements of the same measurand, carried out under the same conditions of measurement.
- **Reproducibility** is the closeness of the agreement between the result of successive measurements of the same measurand, carried out under changed conditions of measurement.



Ref: Guide to the expression of uncertainty in measurement , ISO 1993  
International vocabulary of basic and general terms in Metrology , ISO 1993



# Time and space differences in G-IV & Global Hawk drops

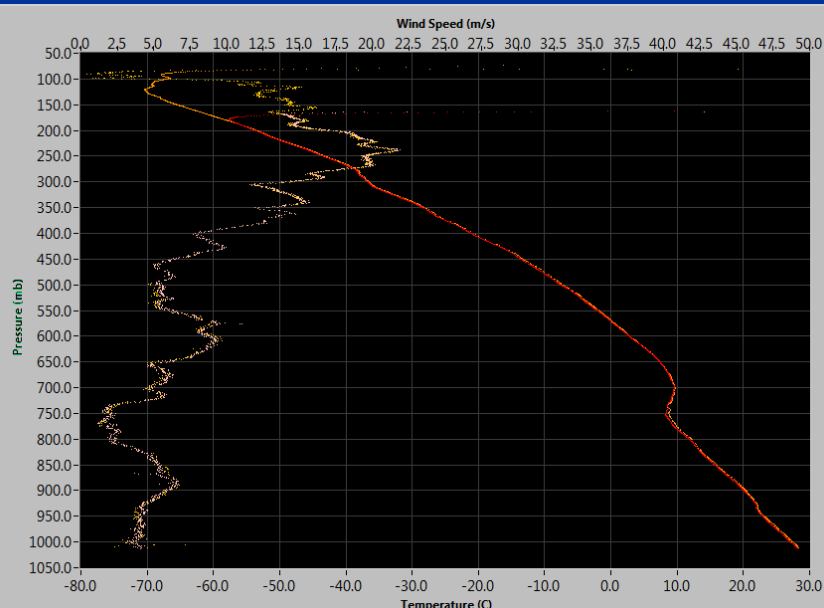
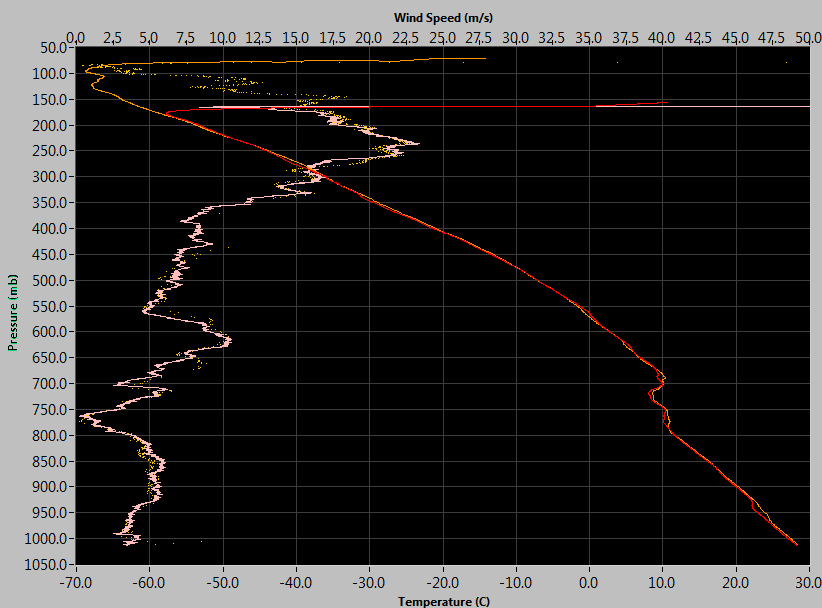
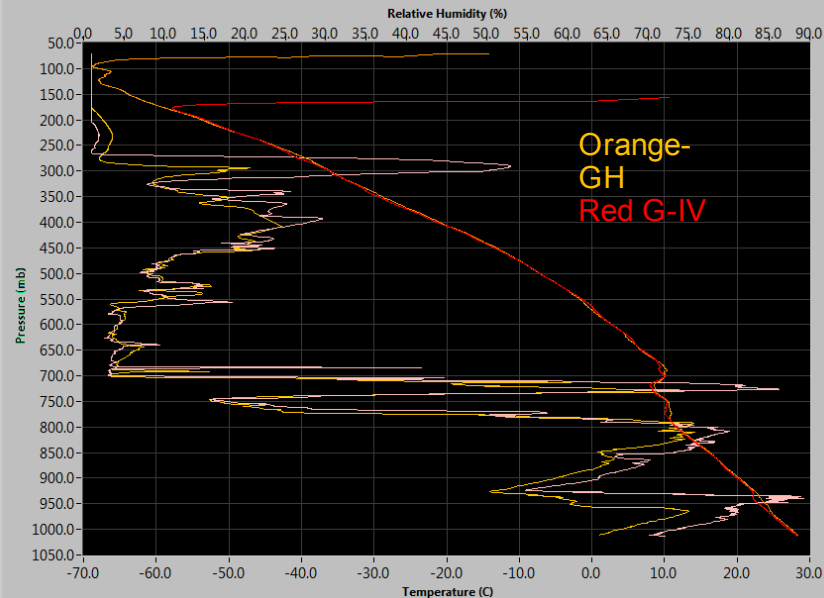
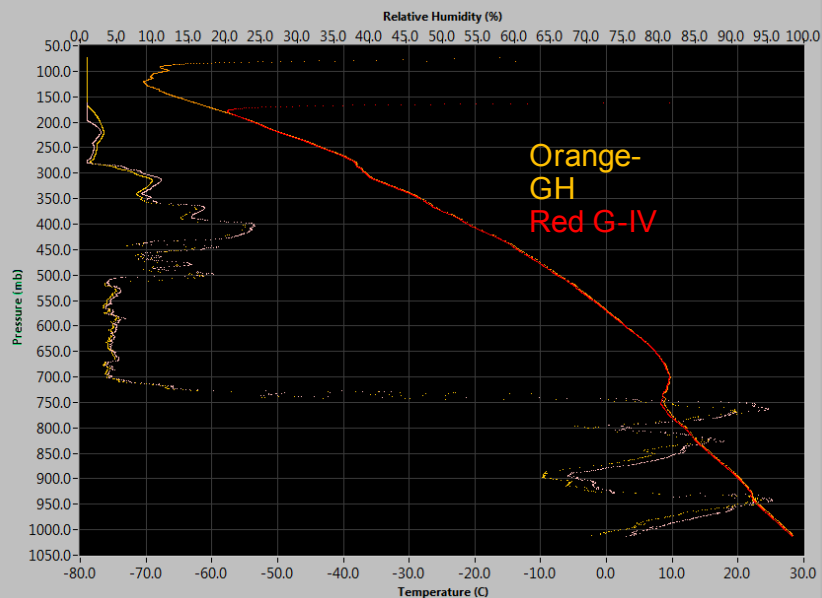


- Average launch location distance between GH and GIV drops is 4.3 km
- Average time difference between GH and G-IV drops is 2.4 minutes

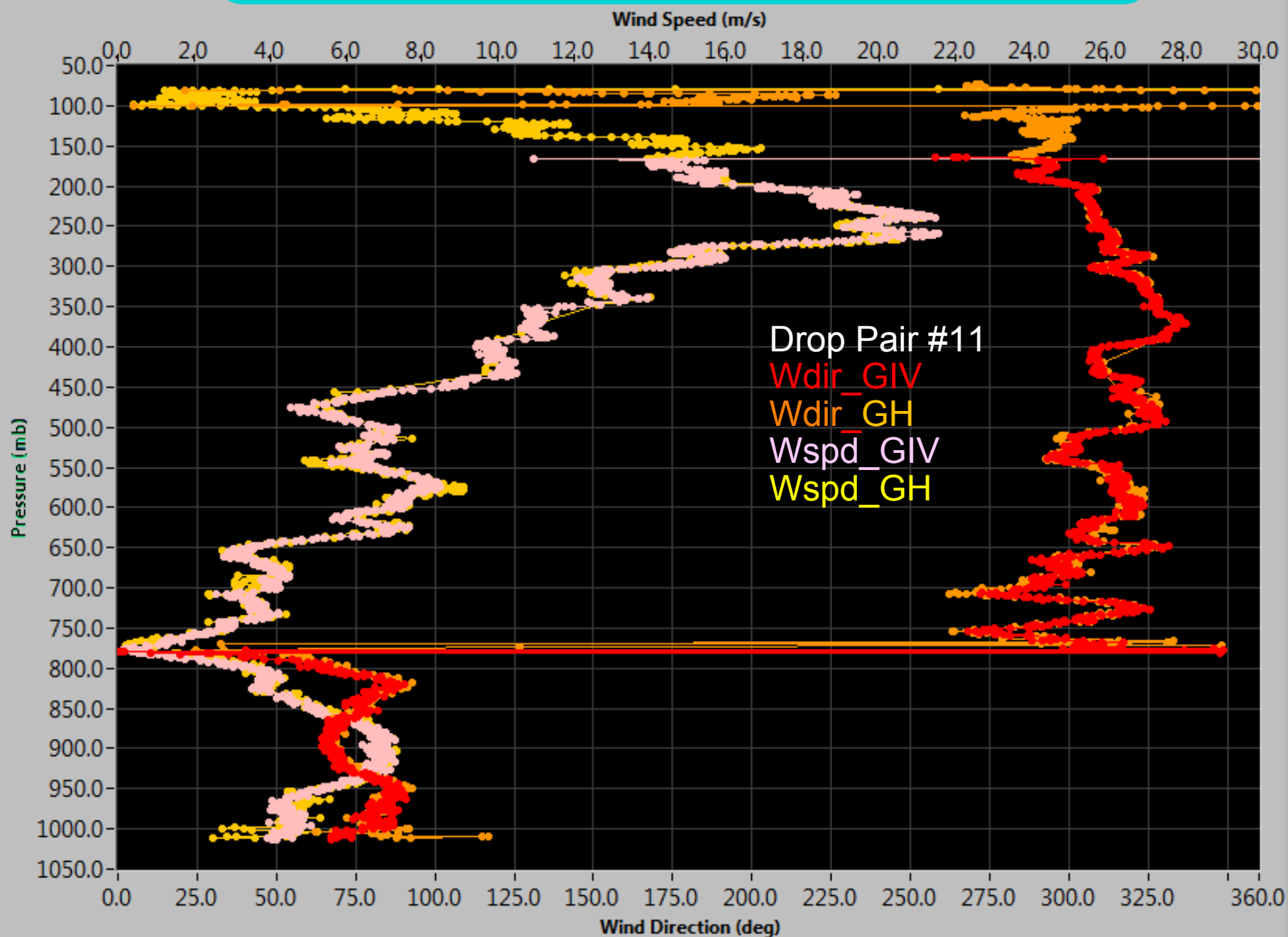
# Typical Sounding Profile Comparison

Drop pair #1

Drop pair #13

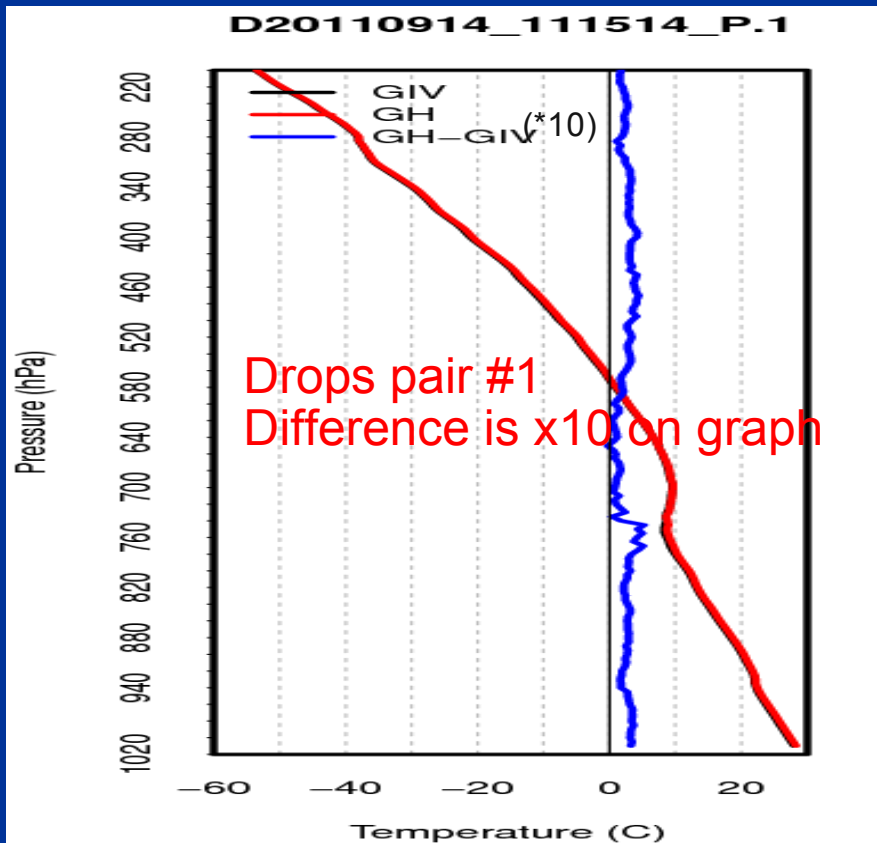


# Wind comparison

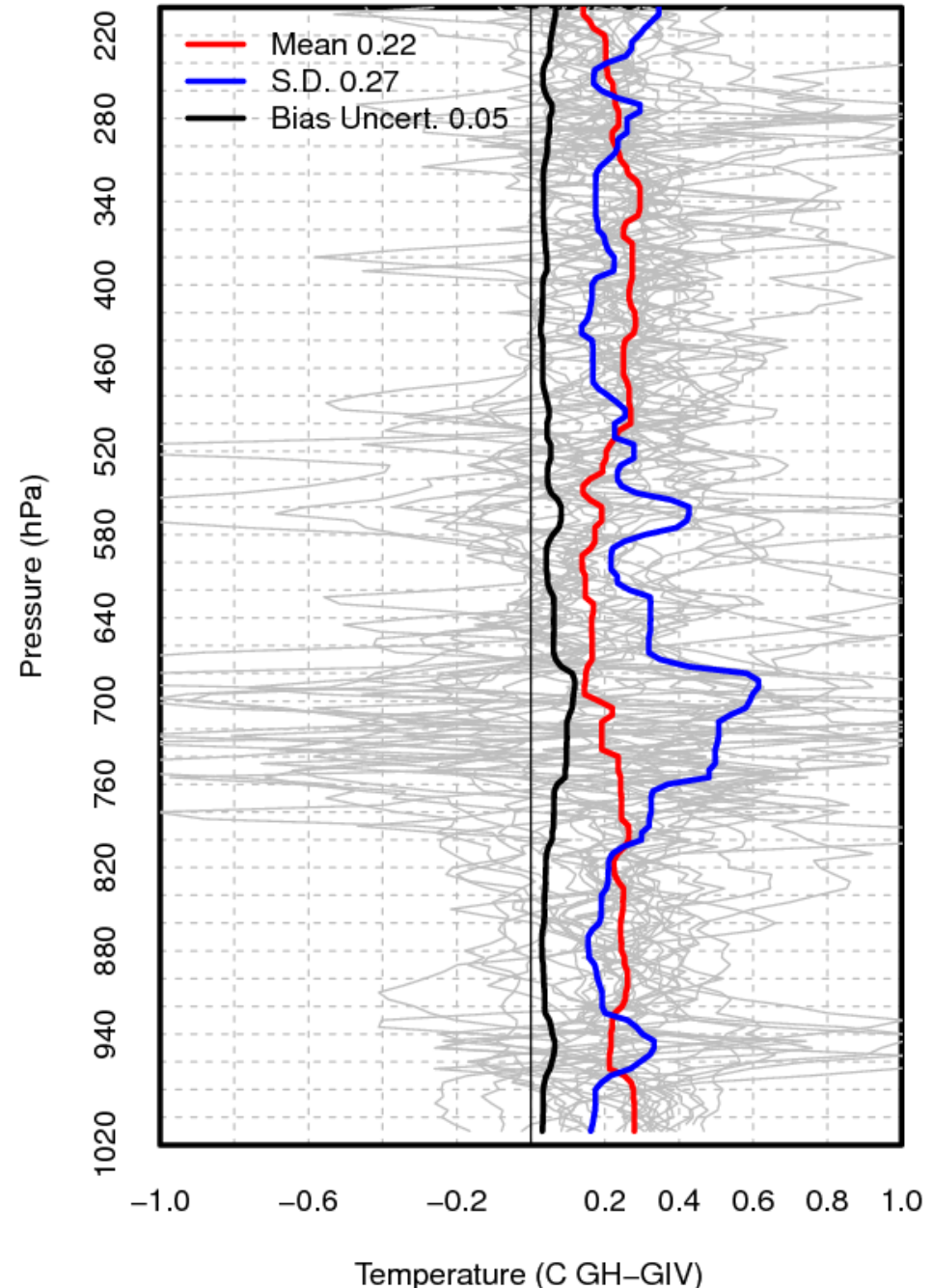


# Temperature Differences

- Suggesting a warm bias in the G.H. data with a mean of  $0.22^{\circ}\text{C}$ .
- The bias is significant comparing with the uncertainty of the bias.
- The reproducibility ( $2 * \text{S.D.}$ ) is  $0.54^{\circ}\text{C}$  on average.

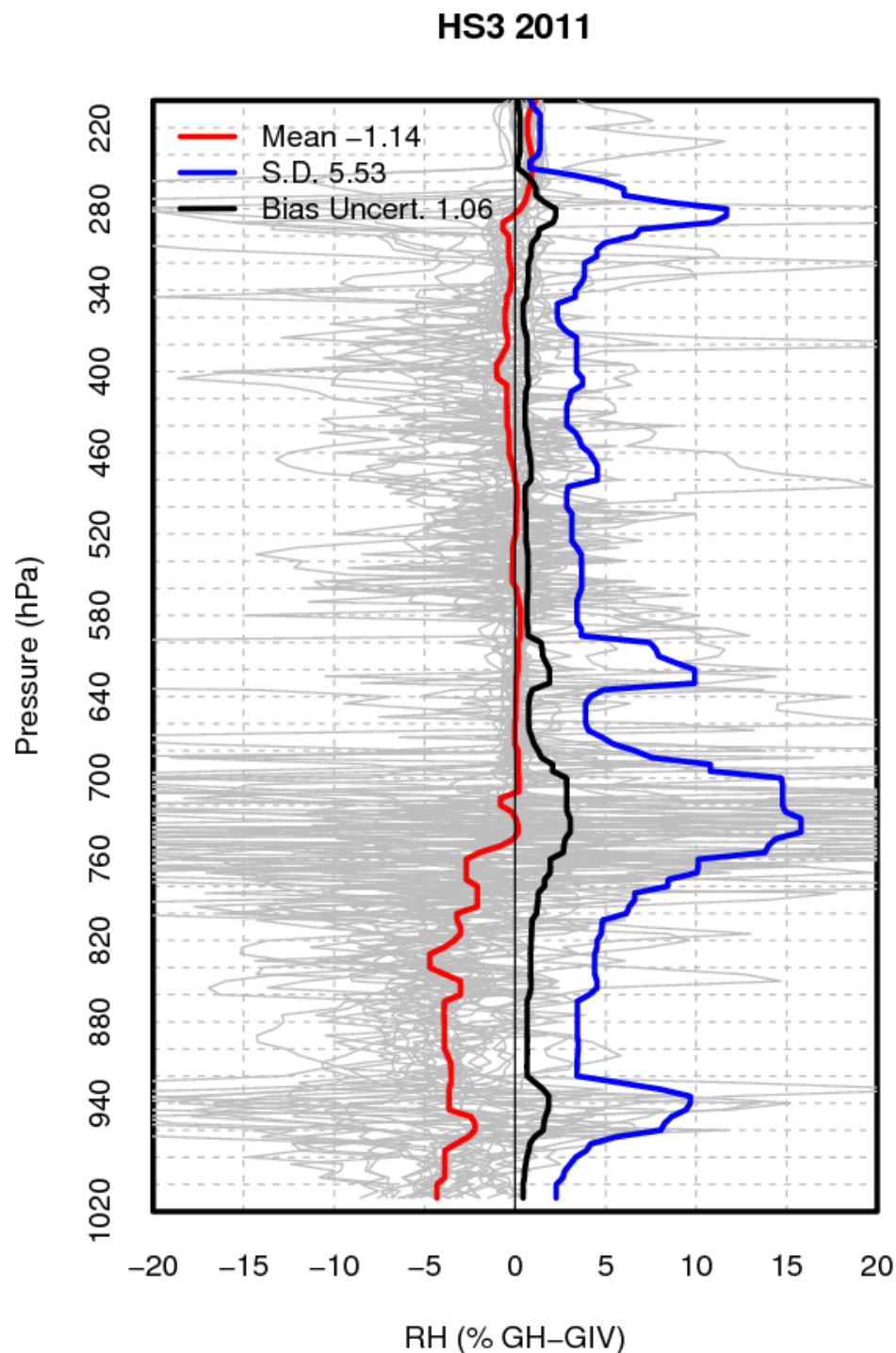
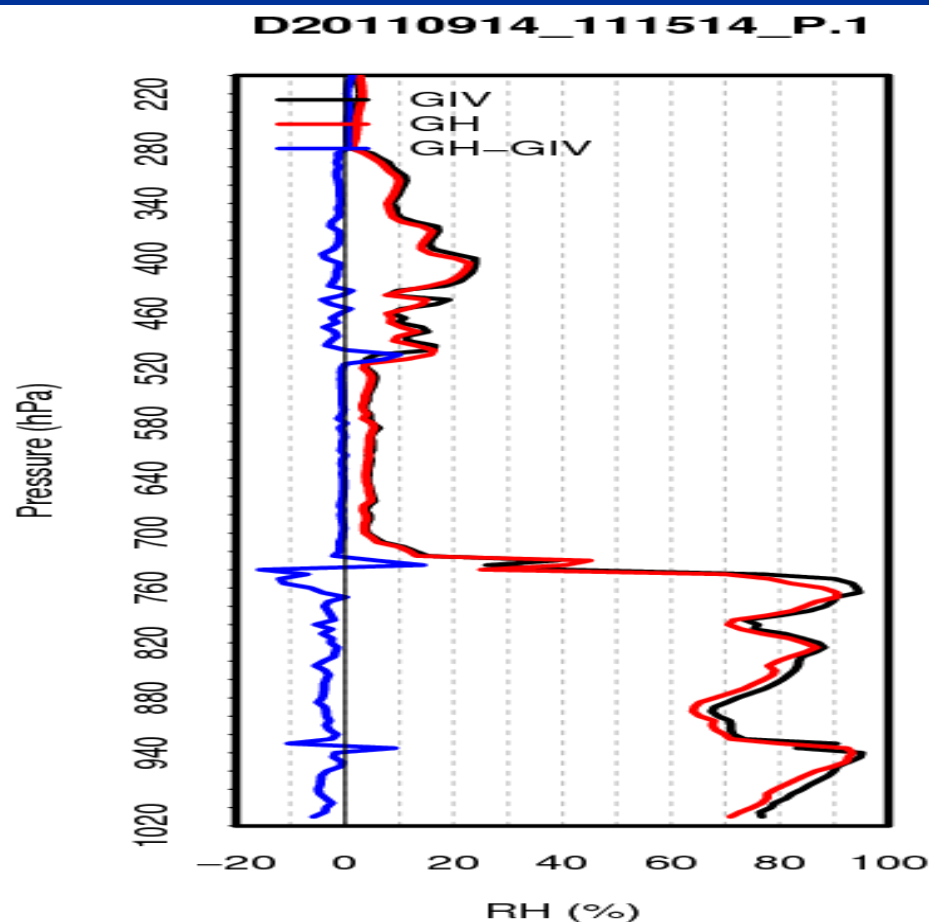


HS3 2011



# RH Differences

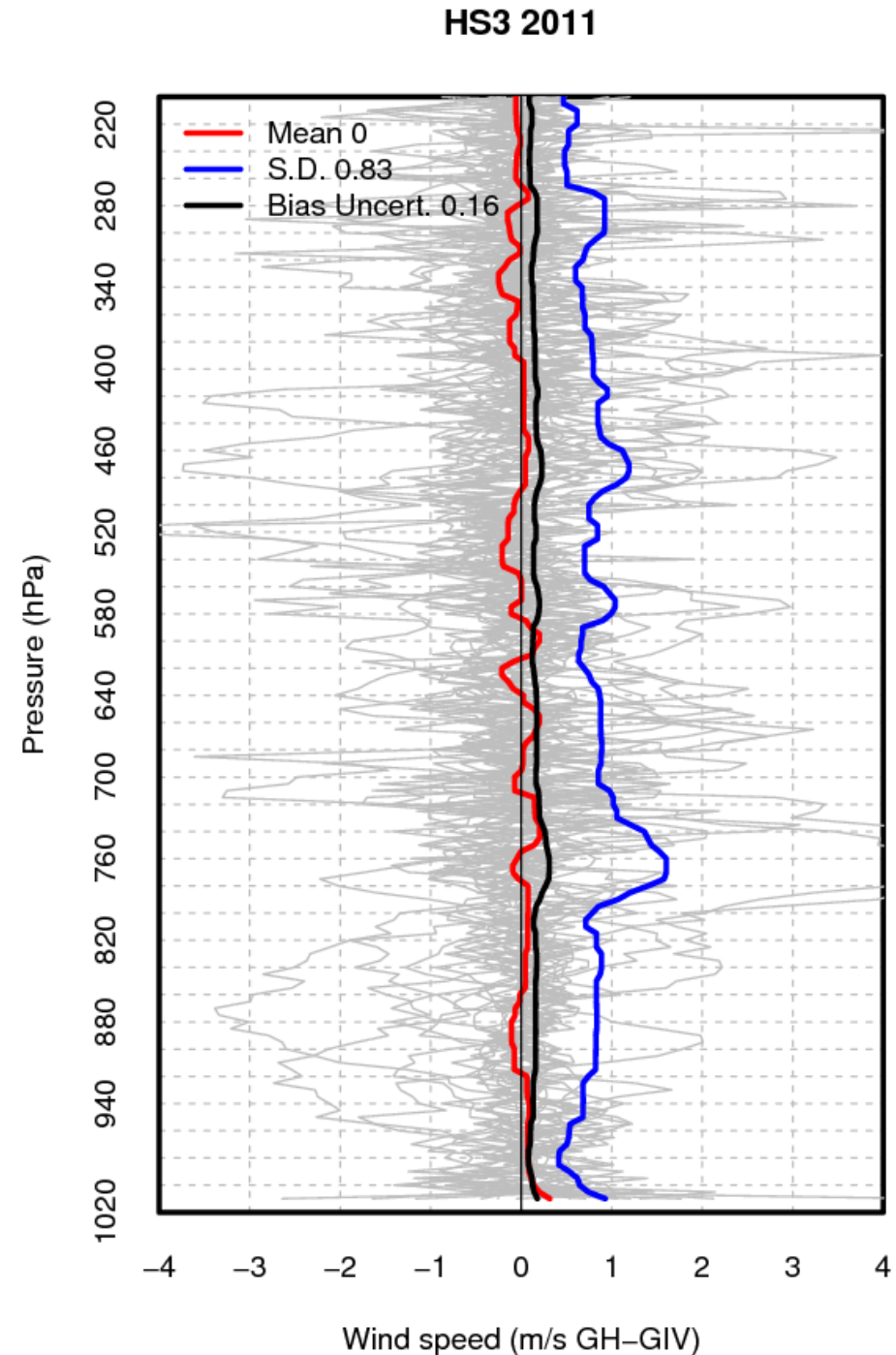
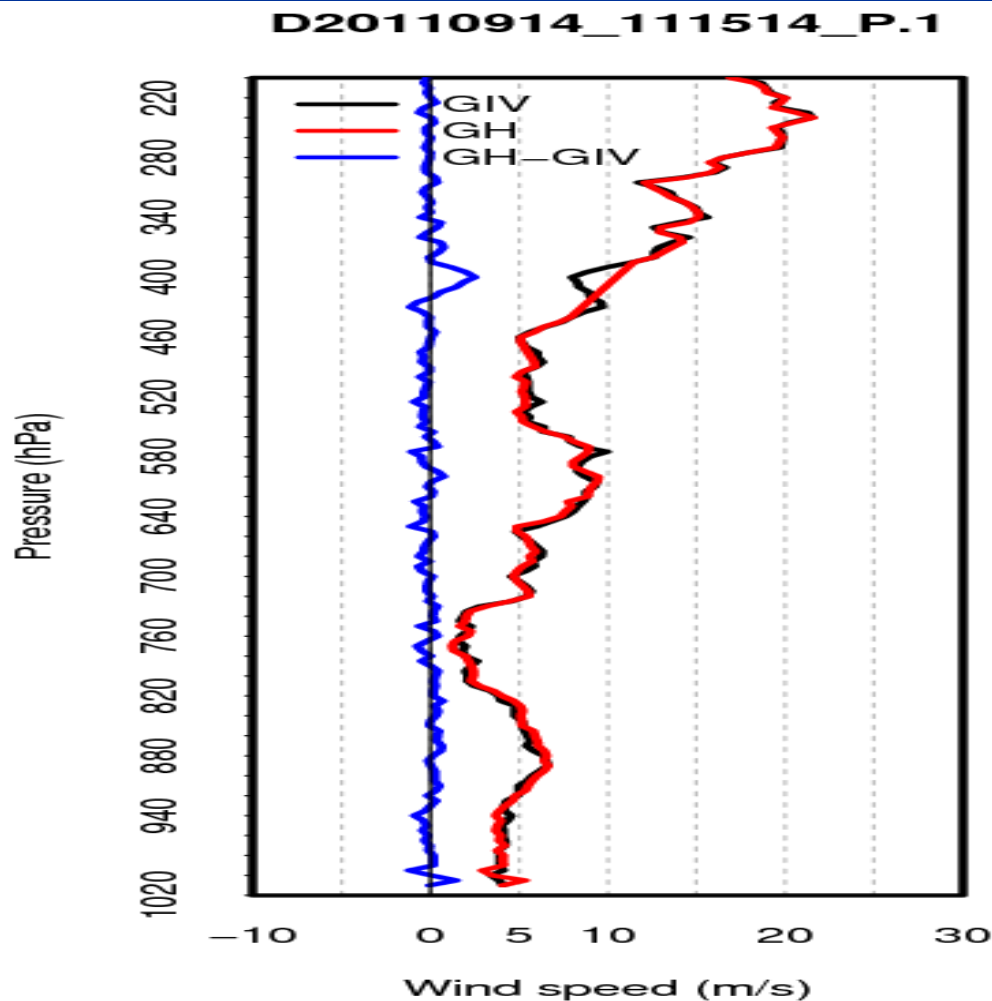
- Good agreement above ~750 hPa.
- A dry bias of ~4% below ~750 hPa.
- The reproducibility ( $2 * \text{S.D.}$ ) is 11% on average.



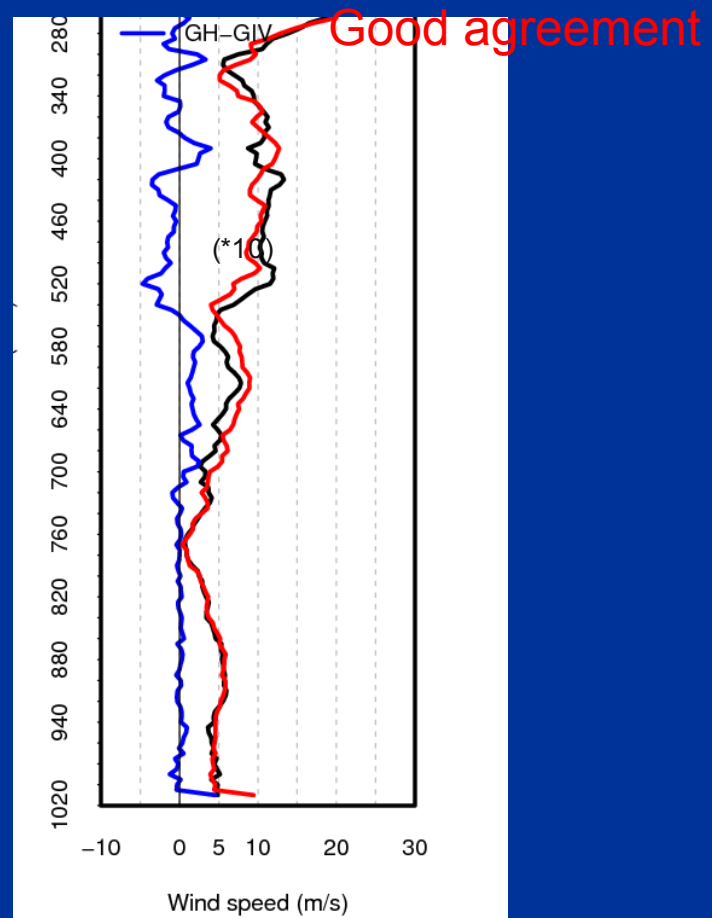
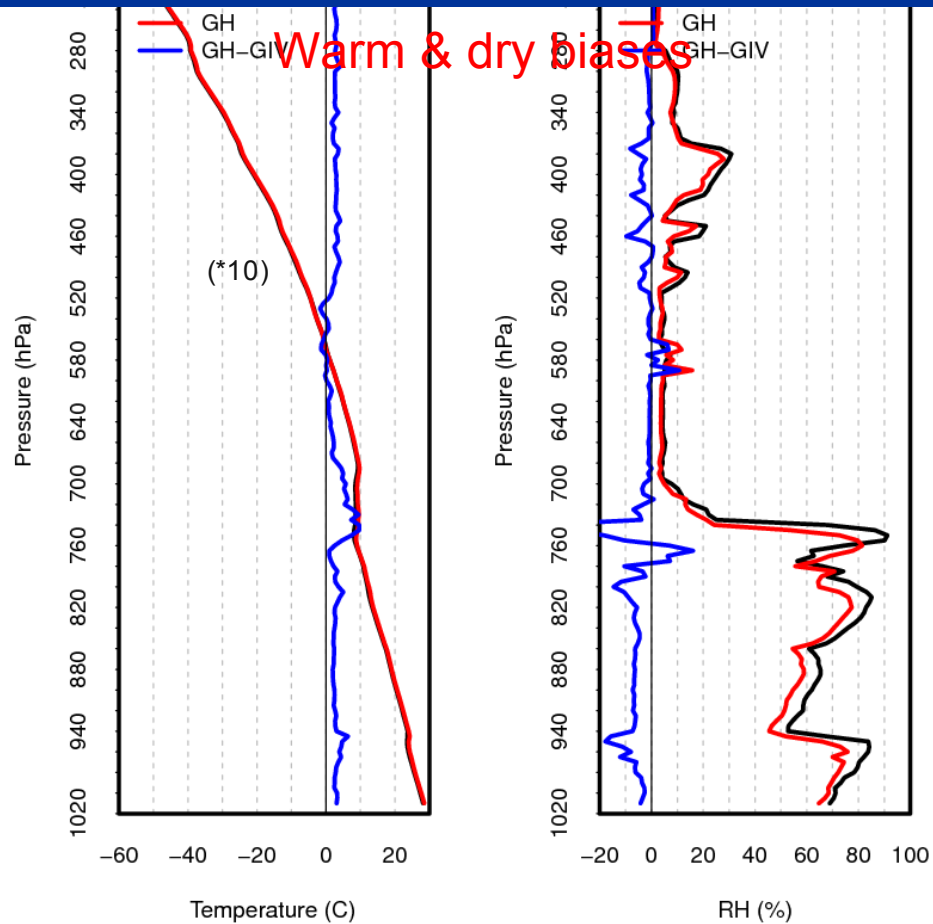


# Wind Speed Differences

- Excellent agreements with no mean bias.
- The reproducibility ( $2 * \text{S.D.}$ ) is 1.66 m/s on average.



# Warm and dry biases in the GH data



# Suspected reasons for warm/dry biases

**Solar radiation heating:** AVAPS II has black radiation foam (BRF) and has PTU sensor module in the shade, so no direct solar radiation heating, while mini-dropsonde used in G.H. has no BRF, and three large windows make it susceptible to direct solar radiation heating.

AVAPS II  
Dropsonde  
(G-IV)

Mini  
Dropsonde  
(G.H.)

Sonde body &  
Radiation shield

BRF

# Comparisons of dropsonde TEMP messages from Global Hawk and NOAA-GIV during HS3

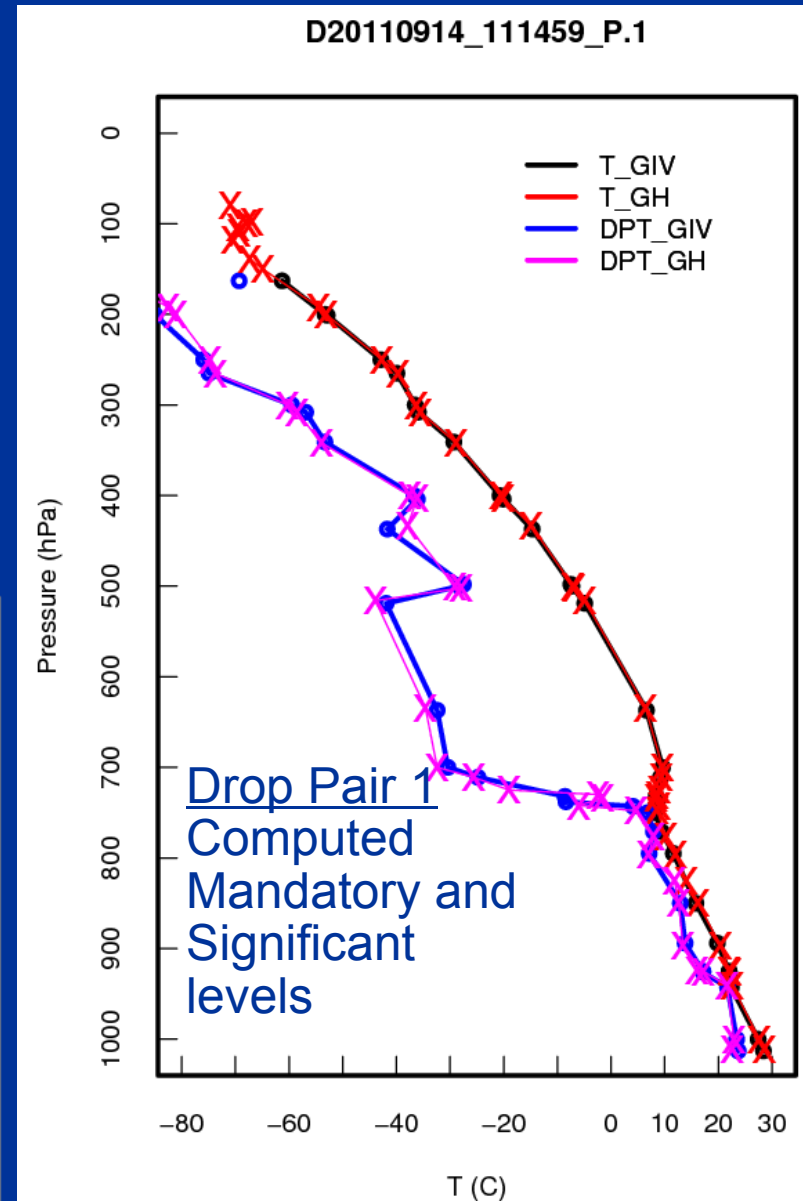
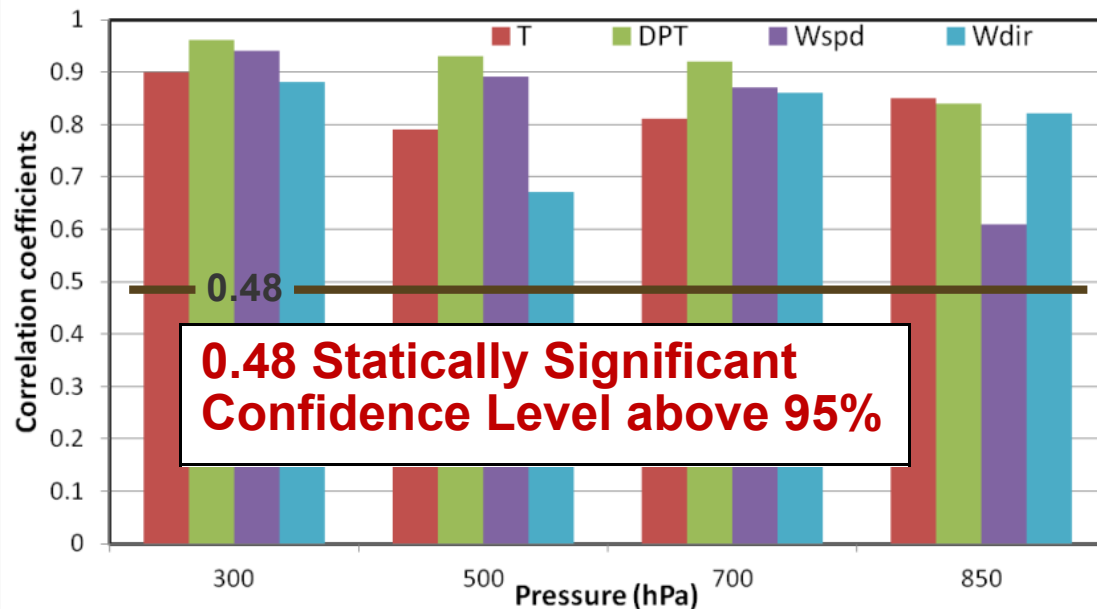
## Atmospheric Sounding Processing Environment

Apply quality control procedures to the sounding data

ASPEN implements Federal Meteorological Handbook No.3 (FMH-3)

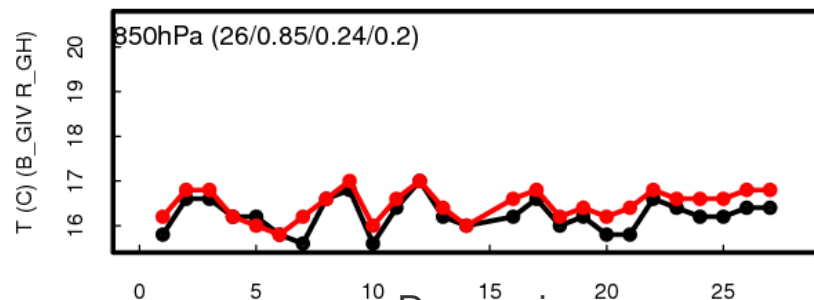
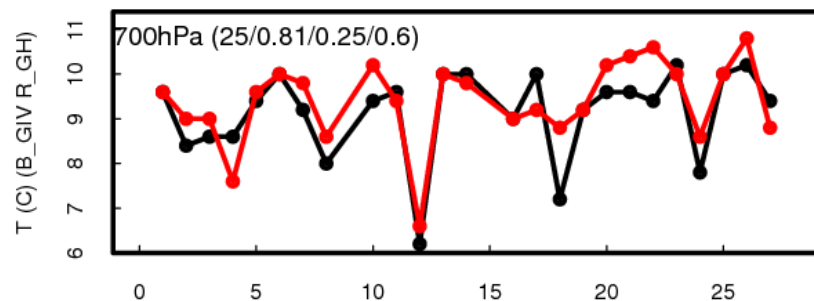
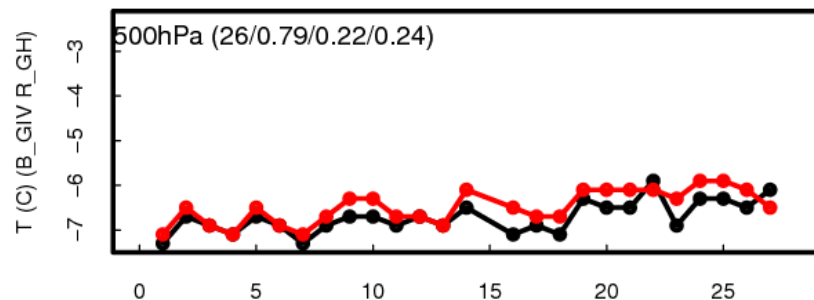
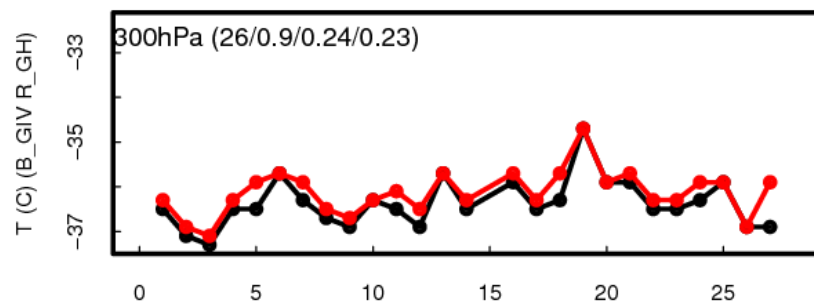
Automatically determine mandatory and significant levels

Code levels in WMO message formats



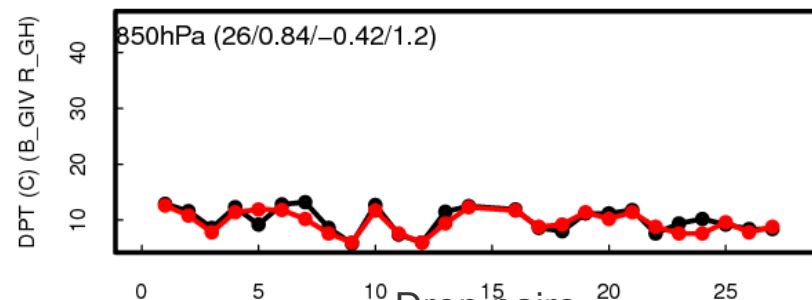
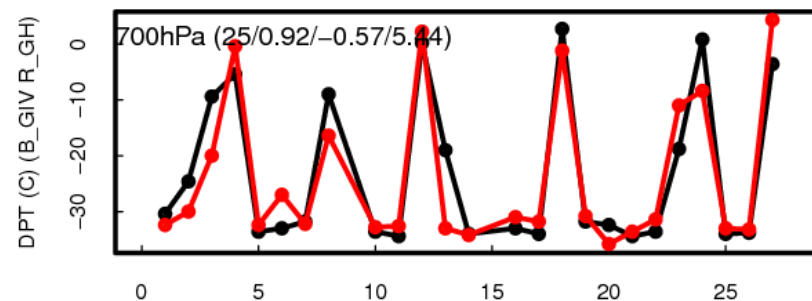
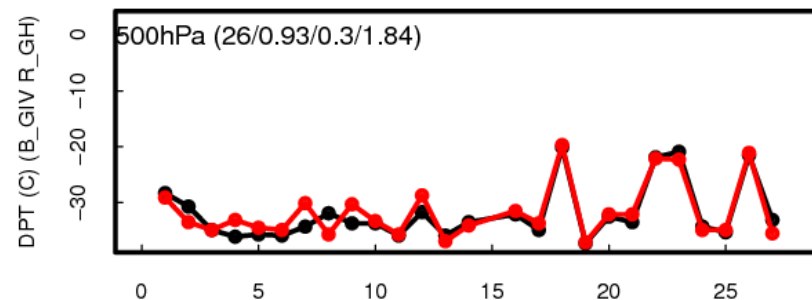
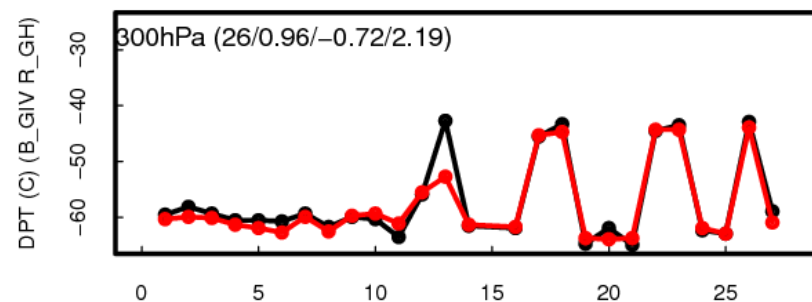
# Comparison of significant levels

## Temperature (G-IV & G.H.)



Drop pairs

## Dew-point T (G-IV & G.H.)

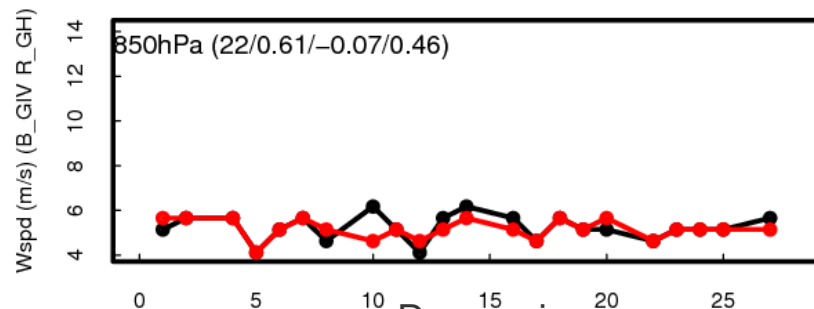
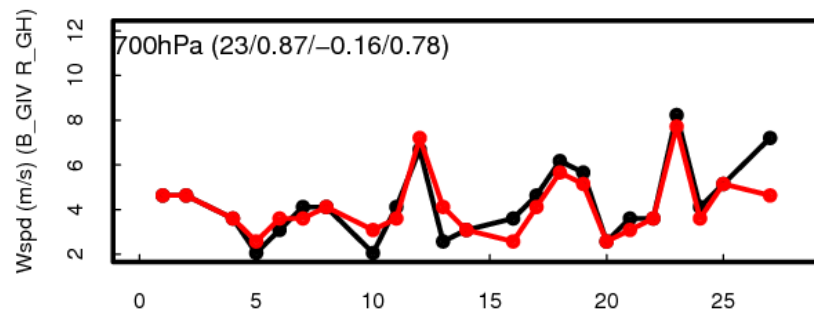
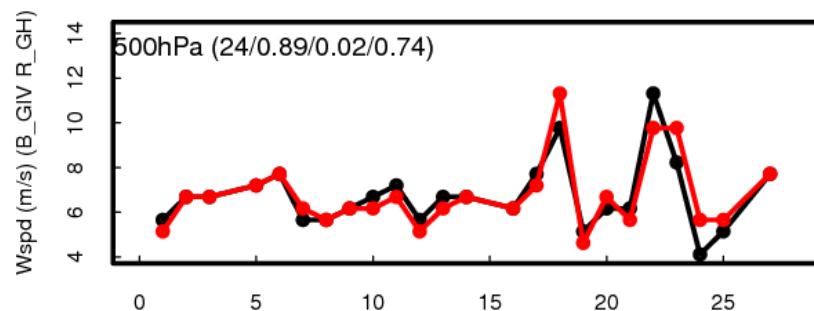
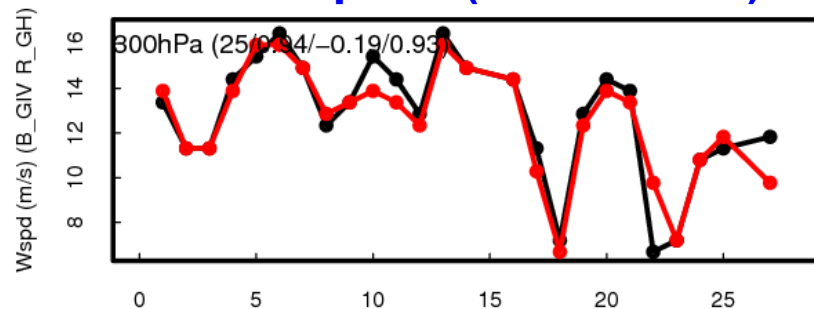


Drop pairs

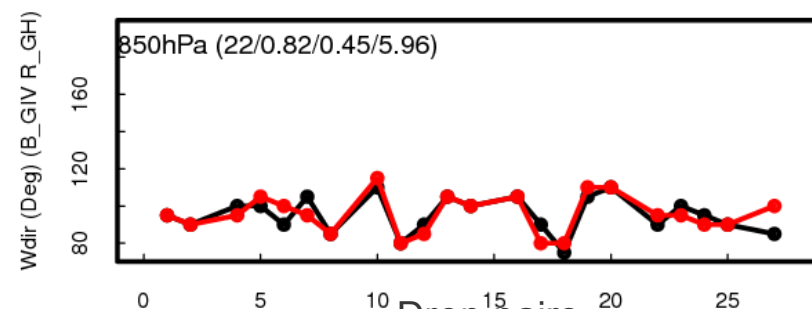
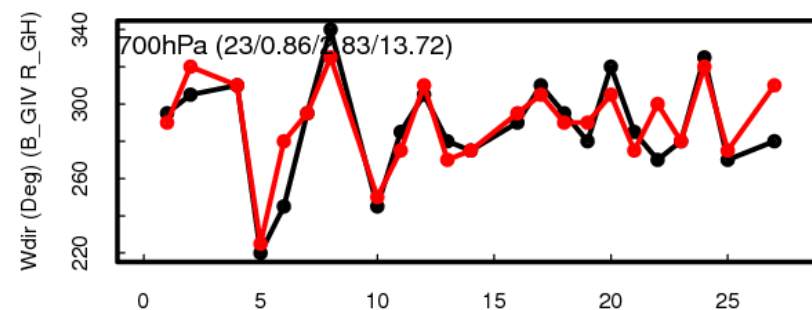
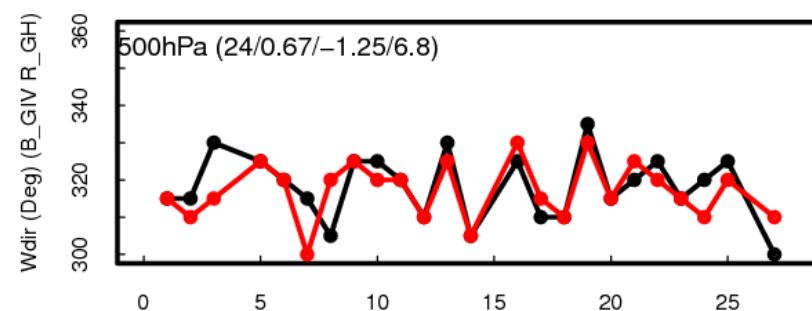
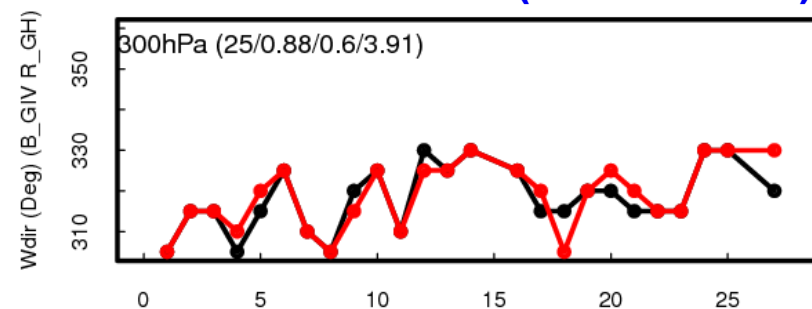


# Comparison of significant levels

## Wind Speed (G-IV & G.H.)



## Wind Direction (G-IV & G.H.)



Drop pairs

Drop pairs



# Summary

Twenty seven pairs of co-located soundings in a similar environment were collected within four hours during daytime from Global Hawk and G-IV.

The comparisons show excellent agreements for wind profiles without any systematic bias.

The temperature from the G.H. shows a warm bias with a mean of  $0.2^{\circ}\text{C}$ .

The RH profiles agree well with each other above  $\sim 750$  hPa, but show a 3-5% dry bias in the GH data below  $\sim 750$  hPa.

Future Lab testing at NCAR to understand and improve the temperature bias.

Comparison of WMO Temp Drop message show excellent agreement